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Determination of the Glass Making Potentials of Seashells from Great Kwa River, South Eastern Nigeria

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ABSTRACT

This research study involves the determination of the glass making potentials of seashells obtained from the Great Kwa River, South Eastern Nigeria where there is large quantity of seashells deposits. The aim is to ascertain the glass making quality of these seashells. Five seashells species (*Lanister variscus*, *Egeria radiata*, *Thais coronata*, *Tymphanotonus fuscatus* and *Pachymelania aurita*) were obtained and analyzed for the following parameters, CaO, NiO, Fe₂O₃, MgO, NaO, K₂O, TiO, CuO, ZnO, ZrO, P₂O₅, SrO, PbO and pH. The results revealed that calcium oxide (CaO) forms the predominant metal oxide in the entire seashell samples with a percentage mean concentration of 95.59±0.005%, followed by magnesium oxide (MgO) 2.52±0.012%, nickel oxide (NiO) 1.90±0.0014%, iron oxide (Fe₂O₃) 0.089±0.012% and trace amounts of other metal oxides such as MnO, Na₂O, K₂O, TiO₂, CuO, ZnO, ZrO, P₂O₅, SrO and PbO. Physico-chemical analysis shows a high pH value signifying high basic oxides content in the seashell samples. Comparison using population t-test of observed mean of CaO, Fe₂O₃ and NiO with their observed minimum standard (30% for CaO, 0.2% for Fe₂O₃ and 0.5% for NiO) shows that the entire seashell samples can be used as a source of raw material for commercial glass making.

Key words: Seashells, lime, calcium oxide, iron oxide, glass raw materials, glass making

INTRODUCTION

Nigeria is a country endowed with human, natural and mineral resources and one of these natural endowments is seashells (Chang, 2002; Dolley, 2003; Ogogo, 2004). Seashells contain a high proportion of calcium carbonate which if properly utilized can immensely contribute to any nation's economic growth (Firoz *et al.*, 2003; Keller, 2002). Seashells have found wide application on global scale in the area of medicine, trade, art and architecture, music and communication, agriculture, religion and domestic uses. In the United States of America alone, lime obtained from seashells ranks among 50th industrial chemical products, with about \$32.3 million dollars annual output (Davis and Fitzgerald *et al.*, 2004; Claude, 2002). In Nigeria however, the use of seashells is only limited on the domestic scale alone, as most of the teeming population only utilize it for domestic consumption due to its proteinous and mineral content (Chang, 2002) while the shells are constantly thrown away as wastes in spite of their valuable economic minerals content (Claude, 2002). Also, in recent times, there has been persistent agitation by various interest groups in Nigeria for resource control. There has also been great concern for the exploitation of the nation's abundant solid mineral deposits to reduce the pressure on oil. It is therefore desirable to investigate

other ways of generating revenue from our abundant natural resources. One of these ways could be exploitation of shells from seashells deposit for our growing industries especially the glass industry. The basic glass making raw materials are sand (Silica), lime, soda ash and colouring agents (Dolley, 2004; Freestone, 2005). While sand (Silica) is a glass former and constitutes 60-90% of any commercial glass product. Lime and soda ash act as stabilizer and fluxes in any glass batch (i.e., resistance to chemical attack and lowering of silica's melting temperature from 1500°C to 1350°C, respectively) and constitute 10-15% of any glass batch and colouring agent 2-5% (Heck and Hoffmann, 2002; Shackelford and Doremus, 2008). Over the years, limestone has been the major source of lime for the glass industries, however, since the large deposit of limestone in Nigeria is not suitable for glass making due to high Iron oxide content (David, 2005). The objective of this study is therefore, to investigate the suitability of seashells deposits in from the Great Kwa River as alternative source of lime for the growing glass making industry in Nigeria.

MATERIALS AND METHODS

Sampling: Five different species of seashells samples (*Tympanostonus fuscatus*, *Pachymelonia aurita*, *Thais coronata*, *Egeria radiata* and *Lanister variscus*) were collected randomly from the Great Kwa River and its environs (Osuala, 1990). The sampling was carried out between the months of September and December to reflect the late dry season periods when tidal waves influence on the estuary by the Atlanta Ocean is at low level (Asuquo *et al.*, 1999). The collected seashell samples were separated according to their species and put into sample bags (calico bags) and labeled A, B, C, D and E to distinguished them from each other as shown in Table 1 and Plates 1-5. The labeled samples were then taken to the laboratory for pretreatment.

Sample pretreatment: The five samples under investigation were each scrubbed with brush and placed in a plastic bucket, thoroughly washed with distill water and their fleshy parts removed and discarded leaving behind the shell parts. These shell parts were further wash thoroughly in warm water (to remove the remaining fleshy part) and finally rinsed in distilled water. After washing, the samples were then air-dried in the open for one week and finally dried in the oven at a temperature of 110°C for six hours (Allen, 1974).

After drying in the oven, the samples were each homogenized by crushing into fine grains using a crusher- Mangan Model BB200. The crushed fine grains particles were further sieved using a 120 mm mesh to ensure homogeneity of particles size. To avoid contamination of samples, the crusher and mesh were repeatedly washed and rinsed with distilled water each time a new sample was to be crushed and sieved. The pulverized samples were each poured in a clean-dried transparent polythene bag and sealed, to avoid further absorption of moisture from the atmosphere.

Table 1: Sampling code, biological/common names of the seashell samples obtained from the Great Kwa River and its environs

Sample code	Biological/common name	Local name
A	<i>Lanister variscus</i> (concave body's ear)	Nko nko
B	<i>Egeria radiata</i> (common galatea clam)	Nkop
C	<i>Thais coronata</i> (rock shell)	Nko nko
D	<i>Tympa nostonus fuscatus</i> (smooth periwinkle)	Mfi
E	<i>Pachym elania aurita</i> (rough periwinkle)	Mfi



Plate 1: *Lanister variscus* shells



Plate 2: *Egeria radiata* shells



Plate 3: *Pachymelania aurita* shells



Plate 4: *Thais coronata* shells



Plate 5: *Tympanostonus fuscatus* shells

Determination of Loss On Ignition (LOI): Ten gram each of the pulverized sample labeled A-E were taken and carefully placed in a clean crucible and weighed using a Mettler analytical balance. The weighed samples were then placed in an electric muffle furnace and heated for 1 h at 950°C to determine the loss on ignition.

The ignited samples were allowed to cool at room temperature in a dessicator and then carefully poured into clean-dried sample bottles, properly labeled and sealed using masking tape and taken to the National Metallurgical Development Center Jos, Plateau State for chemical analysis.

Sample digestion: The digestion of the pre-treated samples, for metallic oxides concentration analysis was carried out using 10 cm³ concentrated Hydrochloric acid (HCl), to release the metal oxides content into solution (Rantala and Loring, 1992; Ademoroti, 1986).

For each of the representative pretreated samples, 0.2 g was carefully weighed and placed in a clean-dried crucible and 10 cm³ concentrated Hydrochloric acid (HCl) added. The acid used was of analytical grade. The mixture was placed on a hot plate, in a fume cupboard and heated slowly to about 50-60°C for 2 h. The 2 cm³ of concentrated HCl acid was added once more and the heating continued until a clear digest solution was obtained. The clear digest solution was cooled at room temperature and carefully filtered into a plastic volumetric flask and made up to 100 cm³ with de-ionised water and allowed to stay for three days before analysis using Atomic Absorption Spectrophotometer (AAS). All glass wares and specimen bottles used were initially washed thoroughly with HNO₃ and rinsed with de-ionised water (Sinex *et al.*, 1980).

Determination of metal oxides concentration: This was carried out using Atomic Absorption Spectrophotometer (AAS), Unicam Model 969 equipped with absorption and flame emission mode. The absorption mode was used to determine Fe₂O₃, CaO, MgO, MnO, P₂O₅ and PbO while the emission mode was used for the determination of K₂O and Na₂O. Working standard solutions of the elements were prepared for each metal. The standard solutions and aliquots of the diluted clear digest were used for the determination. Also, standard curves were used to establish the relationship between absorption and concentration (Underwood and Day, 1988; Emufurieta *et al.*, 1992). To overcome matrix interferences, all reagents used to treat the samples were added to the working standard in the same proportion (Bilos *et al.*, 1998). The detection limit of the AAS was <0.001 mg L⁻¹.

Other metal oxides (ZnO, CuO, SrO, ZrO, NiO and TiO) were however, determined using X-ray Fluorescence spectrophotometer (XRF), Minipal model 1400 equipped with automatic

processing unit system. A specific amount of each of the dried pulverized samples was introduced into the sample cup to (about three quarter 3/4) height of the cup and the edges tapped gently for 10 sec, until the sample level in the cup remained constant. The cup containing the sample was then introduced into the analyzer and the lid closed. The analyzer was then calibrated using the software attached to it and the analysis run for about 40-60 sec and the result automatically printed out. The process was repeated until the entire samples (A-E) were analyzed.

Determination of pH: The pH of the samples was determined electronically using a pH meter of $\pm 0.1\%$ sensitivity model WTW pH 422 the instrument was carefully calibrated using a buffer solution (Krist and Rump, 1988).

Statistical analysis: Data analyses by statistical techniques were carried out using Prozski computer program VERSION 10 out for mean, standard deviation, Pearson's product moment correlation to determine the relationship between calcium oxide and iron oxide. Analysis of variance (one-way ANOVA) was carried out for the percentages of fourteen metal oxides in the five seashells samples.

A regression analysis was also carried out to predict the percentages of calcium oxide using iron oxide. Graphical presentation of results was also done to determine the variation in concentration of all the metal oxides by sample.

RESULTS AND DISCUSSION

Loss on ignition and pH of samples: The results of the analysis obtained from the five seashell samples for loss on ignition (structural water) and pH are presented in Table 2. The result reveals that the structural bound water (H_2O^+) is more in samples A and C and least in sample B which is an indication that samples A and C contain more volatile matter than sample B in the shell structural composition (Ademoroti, 1986) while the pH of the various seashell samples reveals that there is a slight difference in concentration of $\pm 0.02\%$ among the seashell samples A-E. These high values are an indication of the presence of basic oxides that can be used in glass making (Doremus, 1973; Sell, 1981; Ushie *et al.*, 2005).

Metal oxides concentration: The mean percentage oxides composition of the seashell sample A, B, C, D and E are depicted in a bar chart of Fig. 1-5. The results reveal that Calcium oxide (CaO) form the predominant metal oxide in all the seashell samples studied, followed by Magnesium oxide (MgO) in sample A and Nickel oxide (NiO) in samples A and B while the rest of the metal oxides are in trace amount (less than one percent) Most ores or solid minerals do not contain such high concentrations before exploitation is embarked upon (Sell, 1981; Dararutana *et al.*, 2008).

Table 2: Percentage weight Loss On Ignition (LOI)/pH of samples

Sample code	LOI(%)	pH
A	46.10	12.58
B	32.10	12.58
C	43.10	12.59
D	35.16	12.59
E	34.15	12.60

A-E: Sample code, LOI: Loss on ignition

The general pattern of distribution of metal oxides concentration followed the sequence $\text{CaO} > \text{MgO} > \text{NiO} > \text{Fe}_2\text{O}_3 > \text{TiO} > \text{CuO} > \text{Na}_2\text{O} > \text{ZnO} > \text{SrO} > \text{P}_2\text{O}_5 > \text{K}_2\text{O} > \text{MnO} > \text{ZrO} > \text{PbO}$ in the seashell samples. Generally, three basic factors are usually considered before a raw material can be used for Glass making (Shand, 1958; Corning Glass Works, 1967; Greene, 1974; Marson, 1978). These are:

- Purity of the raw material: The material must be free from iron oxide (Fe_2O_3) and other metal oxides that may bring about unwanted colouration in the final glass product or the iron oxide percentage concentration must not exceed 0.015% for optical glass and 0.2% and above for ordinary or commercial glasses. From Fig. 1-5, the distribution of iron oxide across the seashell samples was found to be marginally below one percent (<1%) with the concentration of iron oxides (Fe_2O_3) slightly high in samples A and D with a difference of $\pm 0.05\%$ followed by samples C, E. The least distribution is found in sample B

Pair-Wise comparison of mean percentage concentration of iron oxide (Fe_2O_3) with all the metal oxides mean percentages in the seashell samples reveal that no two metal oxides have the same percentage concentration (Table 3). However, A one-way analysis of variance for the differences in the percentages of CaO, Fe_2O_3 and NiO by sample was carried out. The result is as presented in Table 3. From the result it is observed that the calculated F-value (57.832, 610.989 and 16975.5926), respectively is greater than the critical F-value (4.43 at 0.05, $df = 4, 20$). This means that the mean percentages of each of the three metal oxides (CaO, Fe_2O_3 and NiO) are significantly different across the seashell samples A-E. For calcium oxide, sample C has the highest mean percentage (95.586%) while the least is in sample D (93.036%).

For Iron oxide, the highest percentage concentration was observed in sample D (0.940%) while the minimum was observed in sample B (0.322%). Further comparison of the observed mean percentage of iron oxide (Fe_2O_3) with minimum percentage standard using a population t-test (Table 4) shows that the entire seashell samples can be used as a source of raw material for iron oxide (Fe_2O_3) in glass making especially for samples B and C whose percentages are significantly lower. The amount of Fe_2O_3 that can be tolerated in any glass batch however depends on the types of glass to be produced (Greene, 1974; Marson, 1978).

- The raw material (Ores, solid minerals or samples) must be capable of yielding the required minimum percentage concentration of the metal oxide which is normally between 30-60% of the metal oxide required

From Fig. 1 to 5, the distribution of mean percentage concentration of Calcium oxide (CaO) among the seashell samples is significantly higher than the other metal oxides with sample C having the highest concentration (95.82%), followed by samples A, B and E. The least concentration of calcium oxide is found in sample D with 93.00%.

This high concentration of calcium oxide in the entire seashell samples is in agreement with various research reports that, seashells generally consist of high calcium carbonate content in their shell structures and can therefore be directly used or converted into lime for industrial purposes (Chapman, 1977; Bajah, 1986; Chang, 1991; Malu and Bassey, 2003).

The mean percentage concentration of calcium oxide in the various seashell samples (A-E) were compared with the observed mean percentage standard for glass making (Table 4) and found to be highly significant. This reveals that the entire seashell samples can be used as a source of raw

Table 3: Multiple comparisons of percentages of all oxides by sample

Dependent variable (Seashells)	(l) oxides	(j) oxides	Mean difference (I.J)	Std. error	Sig.	95% Confidence interval	
						Lower bound	Upper bound
A	CaO	Fe ₂ O ₃	93.64800*	0.064	0.000	93.51947	93.77653
		MgO	92.02000*	0.064	0.000	91.8917	92.14853
		MnO	94.49600*	0.064	0.000	94.36747	94.62453
		Na ₂	94.04640*	0.064	0.000	93.91787	94.17493
		K ₂ O	94.49380*	0.064	0.000	94.36527	94.62233
		TiO	94.04020*	0.064	0.000	93.91167	94.16873
		NiO	92.63920*	0.064	0.000	92.76773	92.76773
		CuO	93.97200*	0.064	0.000	93.84347	94.10053
		ZnO	94.25180*	0.064	0.000	94.12327	94.38033
		SrO	94.28200*	0.064	0.000	94.15347	94.41053
		ZrO	94.54060*	0.064	0.000	94.41207	94.66913
		P ₂ O ₅	94.7000*	0.064	0.000	94.34147	94.59853
		PbO	94.54080*	0.064	0.000	94.41227	94.66933
		B	Fe ₂ O ₃	CaO	-93.64800	0.064	0.000
MgO	-1.62800			0.064	0.000	-1.75653	-1.49947
MnO	0.84800			0.064	0.000	0.71947	0.97653
NaO	0.39840			0.064	0.000	0.26987	0.52693
K ₂ O	0.84580			0.064	0.000	0.71727	0.97433
TiO	0.39220			0.064	0.000	0.26367	0.52073
NiO	-1.00880			0.064	0.000	-1.13733	-0.88027
CuO	0.32400			0.064	0.000	0.19547	0.45253
ZnO	0.60380			0.064	0.000	0.47527	0.73233
SrO	0.63400			0.064	0.000	0.50547	0.76253
ZrO	0.89260			0.064	0.000	0.76407	1.02113
P ₂ O ₅	0.82200			0.064	0.000	0.93470	0.95053
PbO	0.89280			0.064	0.000	0.76427	1.02133

*Significant at 0.005 level

Table 4: Comparison of observed percentage of calcium oxide, iron oxide and nickle oxide with their percentage minimum standard

Oxide	Sample	Observe mean (%)	Minimum standard (%)	t	Sig.
CaO	A	94.542	30.0000	381.88*	0.000
	B	95.002	30.0000	1214.58*	0.000
	C	95.586	30.0000	427.14*	0.000
	D	93.036	30.0000	1214.06*	0.000
	E	94.950	30.0000	434.54*	0.000
Fe ₂ O ₃	A	0.8940	0.2000	57.48*	0.000
	B	0.3220	0.2000	14.21*	0.000
	C	0.3400	0.2000	19.81*	0.000
	D	0.9400	0.2000	104.72*	0.000
	E	0.6980	0.2000	25.08*	0.000
NiO	A	1.9028	0.5000	1125.90*	0.000
	B	0.5114	0.5000	-4.38*	0.000
	C**	0.4896	0.5000	+12.38*	0.000
	D	0.5194	0.5000	42.54*	0.000
	E	0.7400	0.5000	37159*	0.000

*Significant at 0.05 level. **Significantly below standard

material for calcium oxide in glass making coupled with the lower mean percentage concentration of iron oxide(Fe_2O_3) which is significantly lower among the seashell samples. It was suspected that there is a relationship between the mean percentage of CaO and that of Fe_2O_3 in all the observed means of the seashell samples. To ascertain this claim, a simple linear regression analysis was carried out. The result is as presented in Table 5-7.

From Table 5, it was observed that the calculated correlation coefficient is 0.740 which is significantly higher than the critical value (0.388). This means that there is a significant but inverse relationship between CaO and Fe_2O_3 in the entire five seashell samples analyzed.

Further analysis was done to determine if the mean percentage of CaO can be predicted from that of iron oxide in the seashell samples. The result is as presented in Table 6. From Table 6, the calculated F-value (27.882) is higher than the critical F-value (7.94) at 0.05 levels and 1, 23 degrees of freedom. This means that the percentage of CaO in the samples (A-E) analyzed depends significantly on the percentage of Fe_2O_3 with CaO increasing with decrease in Fe_2O_3 and vice versa.

An r^2 of 0.49 was observed which means that about 49 percent of the total variation in CaO is accounted for by the presence of iron oxide (Fe_2O_3). When the parameters for the prediction equation were estimated (Table 7) the regression constant was observed to be 96.222 with a standard error of 0.328 while the regression coefficient was found to be 2.503 with a standard error of 0.474 giving a prediction equation as:

Table 5: Descriptive statistics of the percentages of calcium oxide (CaO), iron Oxide (Fe_2O_3) and nickel oxide (NiO) by sample

	N	Mean	SD	SE	95% Confidence Interval for mean			
					Lower bound	Upper bound	Minimum	Maximum
CaO sample								
A	5	94.54200	0.37792	0.16901	94.07276	95.01124	93.900	94.800
B	5	95.00200	0.11967	5.35E-02	94.85342	95.15058	94.880	95.200
C	5	95.58600	0.34334	0.15354	95.07276	96.01230	95.000	95.820
D	5	93.03600	0.11610	5.19E-02	93.18016	93.18016	92.900	93.200
E	5	94.95000	0.33422	0.149474	94.53502	95.36498	94.500	95.350
Total	25	94.62320	0.91552	0.18310	94.24539	95.00111	92.900	95.820
Fe_2O_3 sample								
A	5	0.89400	2.70E-02	1.21E-02	0.86045	0.92755	0.850	0.920
B	5	0.32200	1.92E-02	8.60E-03	0.29812	0.34588	0.300	0.350
C	5	0.34000	1.58E-02	7.07E-03	0.32037	0.35963	0.320	0.360
D	5	0.94000	1.58E-02	7.07E-03	0.92037	0.95963	0.920	0.690
E	5	0.69800	0.144E-02	1.98E-02	0.6289	0.75311	0.650	0.770
Total	25	0.63880	0.27074	5.41E-02	0.52704	0.75056	0.300	0.960
NiO sample								
A	5	1.9028	2.786E03	1.55E-06	1.90015	1.90545	1.900	1.908
B	5	0.5114	2.059E03	8.48E-07	0.50944	0.51336	0.090	0.515
C	5	0.4896	5.314E03	5.65E-07	0.48459	0.49467	0.489	0.505
D	5	0.5196	1.0198E03	2.08E-07	0.50969	0.52913	0.520	0.521
E	5	0.7400	1.4442E03	4.17E-07	0.73862	0.74138	0.738	0.742
Total	25	0.8344	0.5528	1.22E-02	0.6994	0.069	0.090	0.908

SD: Standard deviations, SE: Standard error

Table 6: Comparison of observed percentages of calcium oxide, iron oxide and nickel oxide with their percentage minimum standard

Oxide	Sample	Observe mean (%)	Minimum standard (%)	t	Sig.
CaO	A	94.542	30.0000	381.88*	0.000
	B	95.002	30.0000	1214.58*	0.000
	C	95.586	30.0000	427.14*	0.000
	D	93.036	30.0000	1214.06*	0.000
	E	94.950	30.0000	432.54*	0.000
Fe ₂ O ₃	A	0.8940	0.2000	57.48*	0.000
	B	0.3220	0.2000	14.21*	0.000
	C	0.3400	0.2000	19.81*	0.000
	D	0.9400	0.2000	104.72*	0.000
	E	0.6980	0.2000	25.08*	0.000
NiO	A	1.9028	0.5000	1125.90*	0.000
	B	0.5114	0.5000	-4.38*	0.000
	C	0.4896	0.5000	+12.54*	0.000
	D	0.5194	0.5000	42.54*	0.000
	E	0.7400	0.5000	37.159*	0.000

*Significant at 0.05 level. **Significantly below standard

Table 7: Pearson product moment correlation between CaO and Fe₂O₃ in sample A-E

Analysis	CaO	Fe ₂ O ₃
Pearson correlation		
CaO	1.000	-740
Fe ₂ O ₃	-740	1.000
Sig. (1-tailed)		
CaO	0.000	
Fe ₂ O ₃	0.000	
N		
CaO	25	25
Fe ₂ O ₃	25	25

$$y = 96.22 - 2.503x$$

where, y is percentage presence of CaO and X is percentage presence of Fe₂O₃.

For nickel oxide (NiO) the mean percentage distribution is moderately low among the entire seashell samples (Fig. 1-5). The distribution of NiO is slightly above one percent in sample A (1.90%) followed by sample E (0.74%) and a marginal mean percentage concentration of ±0.01% in samples B, C and D. comparison of the observed mean standard of NiO with minimum standard for glass making (Table 4), shows that the entire seashell sample can be used for glass making with the exception of sample C (0.49%) which its mean percentage is significantly less than the minimum standard (0.5%).

For Magnesium Oxide (MgO), its spatial distribution among the seashell samples (Fig. 1-5) is marginally above 2% in sample A and below 1% in samples B, C, D and E and therefore is of no significant value in glass making (Greene, 1974; Marson, 1978).

For the rest of the metal oxides (MnO, NaO, K₂O, TiO₂, CuO, ZnO, SrO, ZrO, P₂O₅ and PbO), their percentage concentrations in the entire seashell samples are below one percent in their

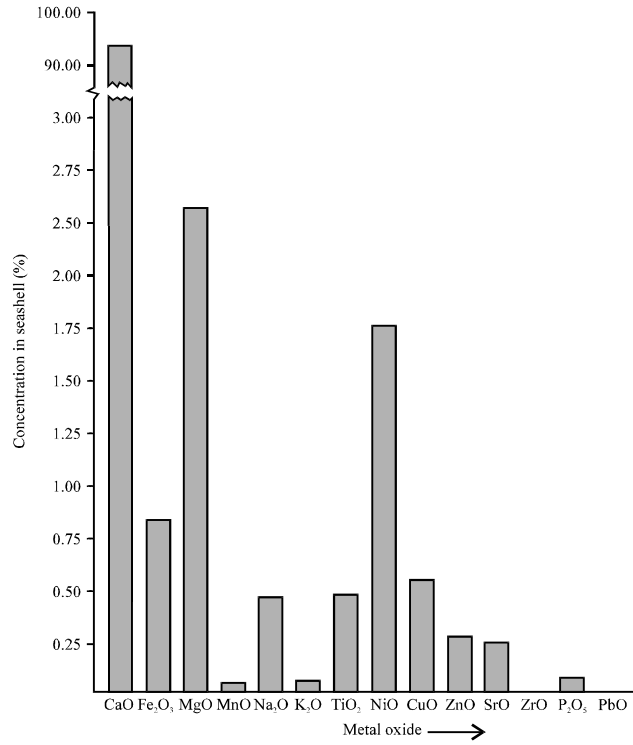


Fig. 1: Bar chart showing concentration of various metal oxide in seashell sample A

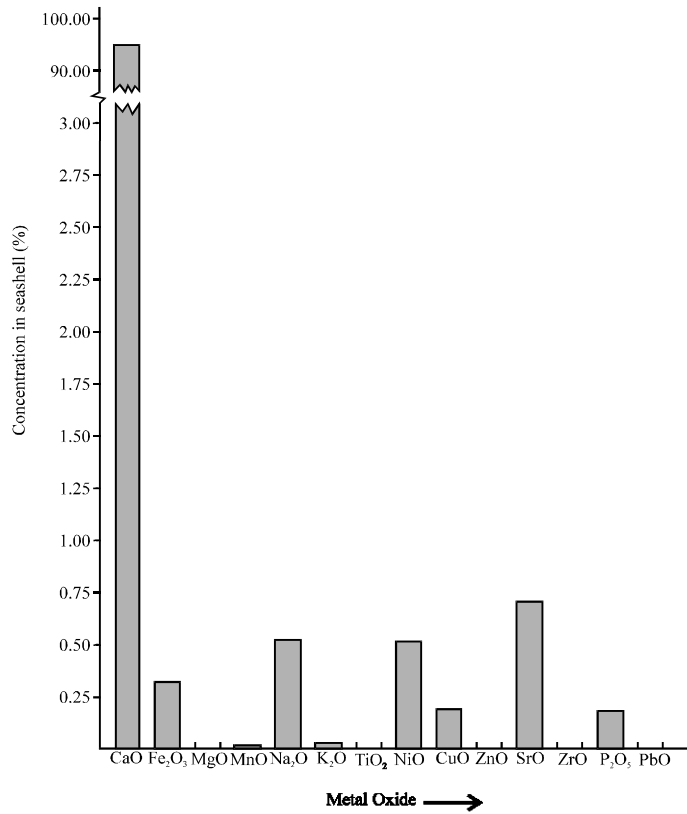


Fig. 2: Bar chart showing concentration of various metals oxides in seashell sample B

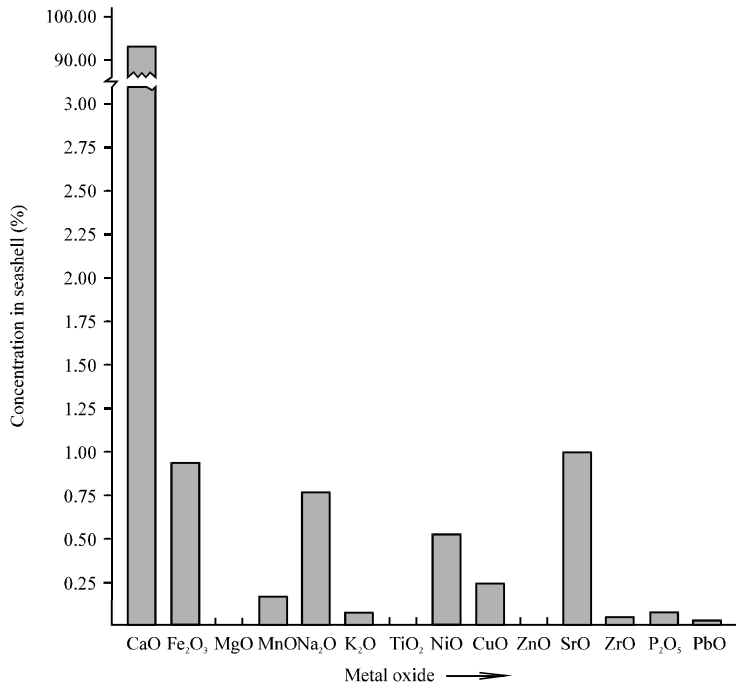


Fig. 3: Bar chart showing concentration of various metals oxides in seashell sample C

distribution and therefore have no commercial significant in glass making (Corning Glass Works, 1967; Greene, 1974; Marson, 1978; Sell, 1981).

- The availability of the raw materials; whether it is relatively cheap or abundant: As earlier stated, seashells are relatively cheap and abundant, especially along the world coastal regions (Chang, 1991; Avril and Ross, 1999; Claude, 2002; Ogogo, 2004). In Nigeria, these seashells are largely deposited along the Riverine, estuaries, mangrove swamps and mud flats as well as in high salinity coastal areas of the south (Oyekan, 1984; Ogogo, 2004). In Cross River State of Nigeria where the samples investigated were obtained, there is a high concentration of seashell deposits along the larger Calabar River Estuaries. This zone is one of the busiest fishing grounds in the whole of the West African coast (Ekpo and Ibok, 1998). Also, there is high concentration of commercial and fishing activities for sea food and beyond in the area (Ekpo and Ibok, 1999; Asuquo *et al.*, 1999). The zone therefore can serve as the source of seashells for industrial purpose especially for the growing glass industries so as to reduce the over dependent on imported lime stone which serves as a source of calcium oxide

This research work involves the determination of the glass making potentials of seashells obtained from the Great Kwa River, South Eastern Nigeria where there is large quantity of seashells deposits and from the results it was observed that the seashell samples generally contain a high concentration of Calcium oxide (CaO) and a lower concentration of iron oxide (Fe₂O₃) contents with trace amounts of MgO, MnO, K₂O, TiO, ZrO, SrO, CuO, P₂O₅, PbO, Na₂O and NiO. A comparison of the five seashell samples, with the standard specifications for glass making show that the entire seashell samples are suitable for use in the glass making industry. Other areas

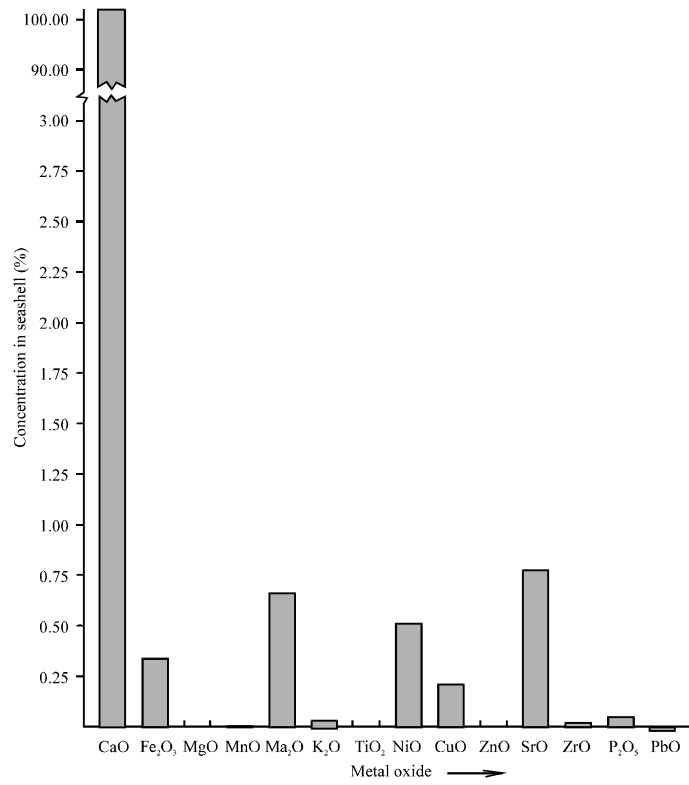


Fig. 4: Bar chart showing concentration of various metals oxides in seashell sample D

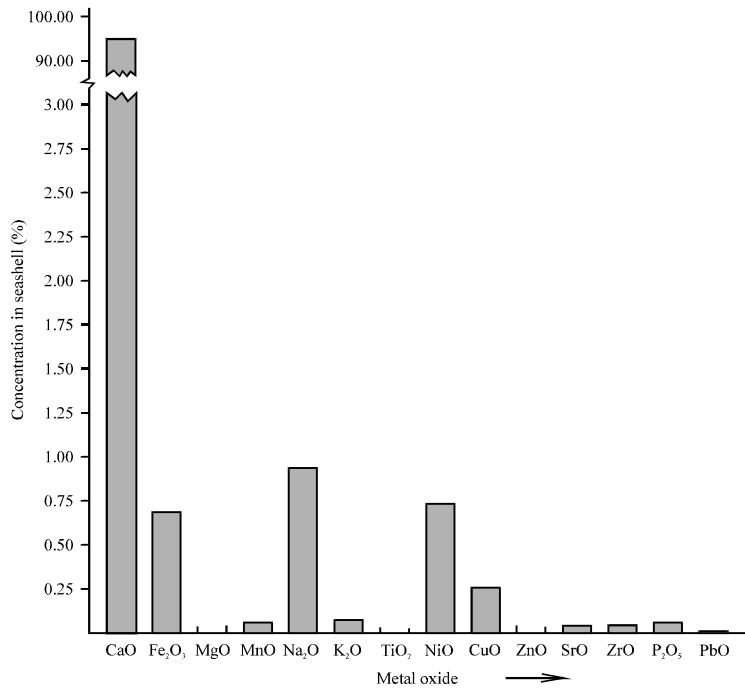


Fig. 5: Bar chart showing concentration of various metals oxides in seashell sample E

which the seashell samples can find application include water treatment plants, agriculture and livestock farming and medicine, pharmaceutical and electronic manufacturing industries.

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